CIRCULAR SERIES

INDEX NUMBER G4.0

PLANNING FOR ELECTRICITY

in the home

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ISSUED BY THE SMALL HOMES COUNCIL

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PLANNING FOR ELECTRICITY SMALL HOMES COUNCIL G4.0

ELECTRICAL PLANNING

Electricity has become important in American homes because it can do much to improve our way of living. Some tasks such as heating, cooking, and refrigeration can be performed also by gas, oil, and other sources of energy. But there are certain things which electricity alone can do. This circular will be devoted to a general discussion of the entire function of electricity in the home, and its relation to planning the home.

The average family use of electricity has increased because more appliances are being used to do work and provide entertainment in the home. In the future, new equipment and appliances will become available which will add still further to the convenience and enjoyment of home life. People who have lived in old houses have experienced the inconveniences and hazards of an inadequate, old-fashioned electrical system. Modern homes must be planned for future uses of electricity so that they, too, will not become out-of-date in a few years. ***Enough is known now*** to insure adequate planning if the fundamentals of electrical use are recognized and put into practice.

Electricity is used to light the home and to operate many appliances. Both of these uses require an adequate supply system.

The supply system serves equipment which makes electricity useful, such as lights, motors, radios, and heaters. Some of these appliances (for example: the kitchen range, the water heater, and the refrigerator) are useful only in specific locations; others can be used in almost any room. Obviously then, electrical planning is a study of: (1) the location of elements of the supply system (switches, outlets, and wiring) and (2) the electrical equipment which the system serves in relation to the plan of the home.

TWO KINDS OF PLANNING

For purposes of planning, the electrical system can be divided into two main classifications:

1. Essential to the structure: The part of the system which must be planned carefully before the house is built.

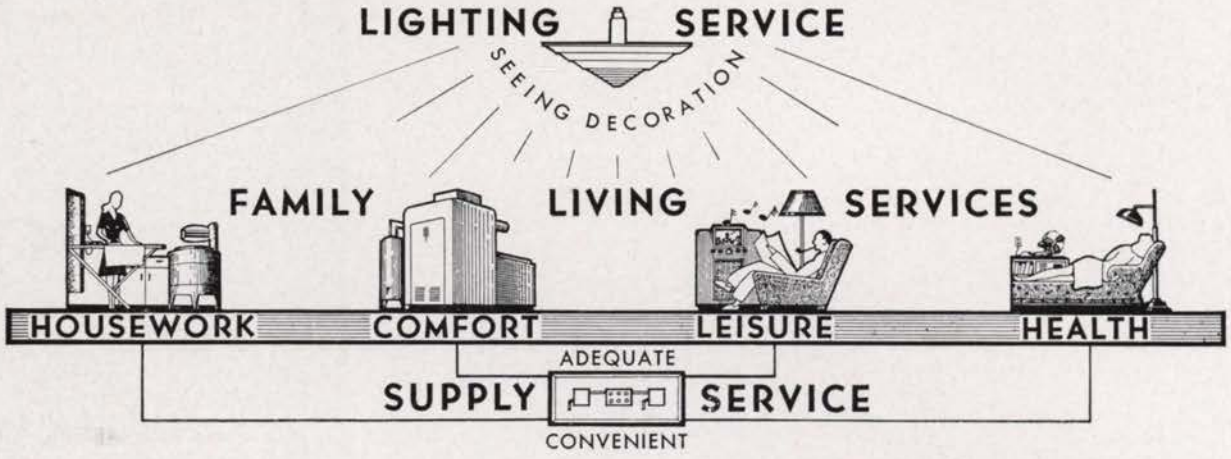
a. The supply system is an essential part of the house structure. The location of outlets, switches, and controls must be marked on the plan.

b. Fixed lights and equipment such as range, refrigerator, and washer should be considered when the home is planned for family living activities, and should be shown on the house plan.

2. Independent of the structure: The part of the system which can be added any time after the house is built (portable lamps, radios, mixers, toasters, and all other appliances which do not depend upon a fixed location for satisfactory use).

Since many articles in #2 obviously depend on the planning of outlets in #1, all uses of electricity should be considered as completely as possible before the house is built and changes become impractical and expensive.

THE PATTERN OF ELECTRICAL USE



Homes are planned today to serve the needs and activities of our way of life. (*See Small Homes Council Circular C2.1 — "Designing the Home."*) Modern home design includes not only the planning of living space, but the proper use and application of equipment and conveniences within the structure. Electricity should be considered in a similar sense of ***use***, as shown in the diagram above.

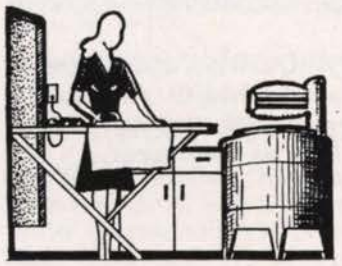
LIGHTING SERVICE: Lighting is not an entirely separate electrical function. In the "Pattern of Electrical Use" lighting is also related to most items of the family living services in that well-placed, sufficient light makes them more visible, therefore more usable.

SUPPLY SERVICE: The wiring system is the unseen foundation of the entire "Pattern of Electrical Use." The adequacy of the wiring system and the proper location of outlets and switches are important to the satisfactory performance of the whole "Pattern."

ELECTRICAL APPLIANCES AND EQUIPMENT

FAMILY LIVING SERVICES: The horizontal center line of the "Pattern" shows four major divisions in which the services of electricity are related to family living activities. Within these divisions can be placed all the appliances or equipment which are operated by electrical motors, heating elements, electronic tubes, or other electrical devices. These are the things which put electricity to work for the family, without which there would be far less importance to planning for electrical use.

- Appliances such as the radio, vacuum cleaner, iron, and washing machine are wanted or used by most families. Some equipment may depend upon the kind of fuel desired for heating or cooking, and may not require electricity. In this circular all electrically operated appliances or equipment are of interest because of their relation to planning the home.
- Each of the four major divisions is analyzed below with a list of the types of electrical appliances designed and made for service or convenience in that division.

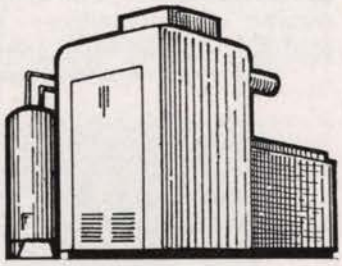


HOUSEKEEPING: In a well-designed home, routine housekeeping is made easier by a variety of well-known appliances which minimize drudgery.

KITCHEN
Range, and minor cooking appliances (such as toaster and waffle iron)
Refrigerator, and freezing and cold-storage appliances
Mixer, and other labor-saving appliances (dishwasher, garbage disposer)

LAUNDRY	GENERAL HOUSEWORK	OTHERS
Washing machine	Vacuum cleaner	Telephone
Ironer, hand iron	Floor polisher	Door announcer
Drier	Sewing machine	Clock

COMFORT: In recent years, building materials and equipment that insure efficient heating have been much improved, and in the future, year-round indoor climate control will be in increasing demand. Although most homes are not heated directly by electricity, they often depend on automatic electrical controls and equipment for complete indoor comfort.

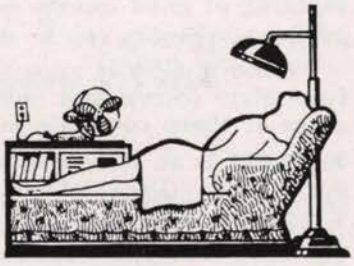


Radiant heater	Room cooler	Automatic heat controls
Air filter	Attic fan	Stoker, oil burner
Electrostatic air filter	Furnace fan	Water heater
Humidifier	Kitchen exhaust fan	Circulating pump

LEISURE: The home owner may spend his hours of relaxation with his hobbies, in indoor play, reading, listening to the radio, or entertaining friends. Many specialized electrical appliances contribute to the enjoyment of leisure. Their cost should be known and anticipated as a part of the home-planning budget.

Radio and television	Electric toys
Phonograph	Photographic equipment
Motion picture projector	Workshop tools

HEALTH AND PERSONAL APPEARANCE: A newer and increasingly larger group of appliances are conducive to the promotion of health for the individual, and other appliances are used as aids to one's good appearance. If outlets are available at the point of probable use, the location of these appliances need not be decided upon when the house is planned. In the future, special lamps will help kill disease germs in the home.



Ultra-violet lamp	Heating blanket	Massager
Infra-red lamp	Heating pad	Razor
Germicidal lamp	Exerciser	Hair drier

CHECKING YOUR NEEDS

You should study this analysis of appliances, deciding what you want electricity to do for you and giving some thought to the possible desires of future occupants of the house.

You should become acquainted with the various appliances and carefully consider their cost. The expenditure for electrical equipment must be proportioned to the cost of the home. Your selection of appliances and equipment should be based on your ability to buy them (1) when the home is built, and (2) at future times.

Make your list of electrical equipment a basic part of your planning.

LIGHTING SERVICE

GOOD LIGHTING is one of the most important services of electricity. To plan for electrical use, you should understand the basic principles of lighting and be able to tell whether your plan makes provisions for the light your family needs. Light is important for:

1. SEEING: Activities in the home involve many seeing tasks which require proper lighting.

2. SAFETY: Good lighting prevents accidents at danger spots, such as stairs and entrances.

3. HEALTH: Proper illumination reduces nervousness, irritability, and fatigue due to eye-strain, thereby improving personal comfort and efficiency. Cleanliness is more easily attained if there is good lighting.

4. DECORATION: Lighting is a significant factor in successful home decoration.

PRINCIPLES OF GOOD LIGHTING

The basic principles of good lighting can be discussed under Quantity, Quality, and Lighting Sources. Each of these relates in some way to the use of light for seeing, safety, health, and decoration. Since light usually performs several of these functions at the same time, the basic principles generally apply to all of the functions. Special applications are discussed here as they occur.

1. QUANTITY

The first requisite of good lighting is an adequate amount of light.

Lighting is measured by a unit called a ***footcandle.*** (This is a level of illumination and must ***not*** be confused with lamp ratings in watts.) Since a light meter — an instrument for measuring the number of footcandles — is not likely to be an article of standard home equipment, it is often made available by the local power company or home demonstration agent.

The type of ***seeing task*** determines the amount of light needed.

1. Severe: Exacting eye-work over extended periods, such as sewing, detailed drawing, or reading of fine print. Currently recommended: 50 to 100 footcandles (usually obtained by local lighting which supplements the general lighting).

2. Close: Seeing tasks such as school lessons, reading, and kitchen and laundry seeing tasks that are not severe. These tasks need 20 to 50 footcandles (also usually obtained by local lighting which supplements the general lighting).

3. General and recreational: Activities which do not require high illumination. From 5 to 20 footcandles may be provided from ceiling or other general lights. Favorite corners and game spots often require the illumination as specified in #1 and #2.

2. QUALITY

Lighting of good quality is the result of adequate quantity and proper control. All the benefits of adequate quantity can be offset by poor control.

Good quality is most important with severe and close tasks. It is dependent upon (A) freedom from glare (direct and reflected), (B) uniformity of lighting on the seeing task itself and the absence of sharp contrasts in the lighting of surroundings, and (C) control of shadows.

A. GLARE is an excessive brightness which causes discomfort or eye fatigue. Glare defeats light in all of its uses.

1. Direct glare comes from a bare bulb (technically, an incandescent or filament lamp), a bare fluorescent tube (technically, a fluorescent lamp), a poorly designed fixture, an over-bright ceiling or side wall, or contrast in brightness between a lamp and its background.

Control: Place the light well above the ordinary line of vision, or diffuse the light with a correctly designed shade or fixture.

2. Reflected glare is more difficult to recognize and therefore is often more troublesome. Glossy objects such as mirrors, table tops, or glass may reflect light into the eyes.

Control: Change the position of the worker or his work, of the lamp, or of the reflecting object. Or do away with the glossy surface entirely.

Courtesy, LaSalle Ext. Univ.

Direct and Reflected Glare

Courtesy, Gen. Elec. Co.

Example of Uniform Lighting

B. UNIFORMITY OF LIGHTING is necessary in the home only where the seeing task is severe or close. Repeated adjustments to greatly contrasting degrees of lighting irritate and tire the eyes. Lighting of surroundings should be adequate to eliminate sharp contrasts. (See illustration.)

Control: Do not use bright lights in an otherwise dark area. Use well-diffused or indirect light for general illumination along with supplementary lights.

- **For decoration:** Uniform lighting similar to office and industrial installations would be undesirable.

C. SHADOW-FREE LIGHTING is required at certain places for ***safety*** in the home. Stairs and hallways should not have shadows which are deceiving and dangerous.

Control: Use fixtures and lamps that diffuse the light over wider areas. Locate lights carefully to avoid shadows.

- **For decoration** or an atmosphere of relaxation, shadows are sometimes desirable.

3. LIGHTING SOURCES

FIXTURES: Electric lighting began with a bare bulb in an ordinary socket. It was a source of glare and other bad effects which could be remedied by the addition of fixtures. Fixtures have three purposes: (1) to control the light, (2) improve the quality of illumination, and (3) make the light source more decorative. Fixtures should be selected first for the quality of lighting they give, second for their decorative appearance. In addition to fixtures, portable lamps or built-in lighting (if properly designed) may be used to give good illumination. ***When buying equipment for lighting, be as careful as you are when buying eye glasses.*** There are many attractive lamps and fixtures on the market which have been designed by experts to produce lighting of the desired quantity and quality for various uses.

Some people still insist that lamps and fixtures reproduce oil lights or candles. Electric light is a modern convenience which should not be spoiled by unadaptable styling.

LIGHT BULBS AND FLUORESCENT TUBES: It makes no difference to your vision whether you choose lighting by common bulbs or fluorescent tubes. Fluorescent tubes cost more, but give about twice as much light for the same number of watts, and last about two and a half times as long. In a home, the cost differences are not enough to influence your own preference. The difference in the shape and size of fixtures for fluorescent and incandescent light offers the means for having any desired variety of lighting effects in your home by using both types of lighting.

COLORED LIGHT SOURCES: Colored bulbs add little or nothing to the comfort you get. They cost more and require a higher wattage to get the same amount of illumination produced by a regular inside-frosted bulb. (Exceptions: "Daylight" bulbs are good where ironing is done or matching of colors is involved.)

TYPICAL LIGHTING SOURCES

1. **Portable Lamp** — diffused direct light and some indirect general light. Excellent reading lamp.

2. **Ceiling Fixture** — good indirect general light. Some designs provide additional direct light from bottom.

3. **Ceiling Fixture** — diffused direct general light. Too close to ceiling for much indirect light.

4. **Ceiling Fixture** — provides more indirect light than number 3. Usually inexpensive.

5. **Fluorescent Ceiling Fixture** — indirect light and good diffused direct light over large area.

6. **Recessed** directional side wall lighting; and 7. built-in indirect **cove** lighting — chiefly decorative and comparatively expensive. Small units may be used to advantage at some places in the average home.

8. Direct **downlight** fixture.

9. **Built-in** lighting with direct downlight (fluorescent or incandescent lamps).

PLANNING FOR GOOD LIGHTING

FOR SEEING: To insure good lighting you must plan for it before the house is built. Analyze your needs for light, and check these points:

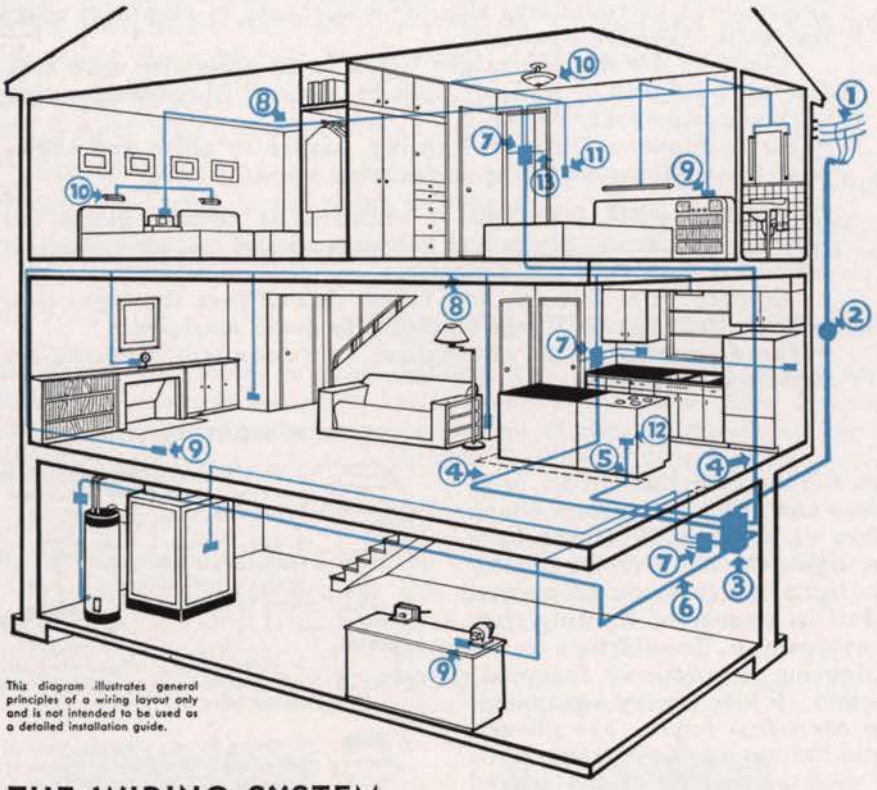
1. Location of severe and close seeing tasks.
2. Points of danger requiring light for safety.
3. Fixed lights for 1 and 2 and also for ***general illumination.*** Halls, basement, and garage need such lights since there is likely to be no other.
4. Provision of outlets for portable lights.

NOTES: Fixtures may be selected after construction is under way. Be sure the fixtures are designed to furnish the lighting needed for each location. Check size and light output of fixtures, clearance of nearby doors, etc.

FOR DECORATION: When the cost of the home justifies, fixtures and built-in lighting can be used purely for decorative effects — provided enough light for seeing is offered by other sources. There are limitless possibilities of creating decoration or atmosphere with light, color, and shadow. Decorative lighting often involves the use of light from coves, recessed panels, or built-in light fixtures, requiring extra cost for structural framing beyond the budget of the low-cost home.

If you keep in mind the principles of good lighting, which are discussed above, you can select well-designed, ***inexpensive*** fixtures that serve seeing and decoration at the same time.

SUPPLY SERVICE: WIRING



This diagram illustrates general principles of a wiring layout only and is not intended to be used as a detailed installation guide.

MAJOR ELEMENTS OF A RESIDENTIAL WIRING SYSTEM

1. SERVICE — Main Highway
2. METER — Toll Station
3. MAIN DISTRIBUTION CABINET
4. SUB FEEDERS — Main Roads
5. RANGE CIRCUIT — Main Road
6. WATER HEATER CIRCUIT — Main Road
7. BRANCH CABINETS
8. BRANCH CIRCUITS — Side Roads
9. CONVENIENCE OUTLET
10. LIGHT OUTLET
11. WALL SWITCH
12. SPECIAL OUTLET
13. OTHER CIRCUITS NOT ILLUSTRATED

THE WIRING SYSTEM

can be thought of as a system of highways, main roads, and side roads over which electricity travels. The main highway consists of wires which carry the current from the power company's lines into the house. This main highway, called the ***service***, passes through the toll station (***meter***) and ends at the ***main distribution cabinet***. In the cabinet is a device that can be used to disconnect all wiring in the house from the power company's lines. Usually ***fuses*** or ***circuit breakers*** for the main highway are contained in the cabinet; it always has fuses or circuit breakers that protect the main roads, which go from the highway to ***branch cabinets*** and special appliances such as an electric range or water heater. The main roads serving individual appliances are given names such as range circuit and water-heater circuit, and the main roads going to branch cabinets are generally called ***sub-feeders.*** Each branch cabinet contains fuses or circuit breakers that protect the ***branch circuits*** (side roads), which radiate to light fixtures and convenience outlets.

Branch cabinets may or may not be used in a house of five rooms or less. If there are no branch cabinets, the branch circuits radiate directly from the main distribution cabinet (often located in the basement or on the first floor).

NECESSITY FOR PLANNING: Today the electrical wiring system should be planned when the house is designed, not after construction has started. To give satisfaction at lowest cost ***over a long period,*** the wiring system must be planned to be: (1) safe, (2) economical, (3) adequate, and (4) convenient.

SAFE WIRING

A safe wiring system offers protection against electric shock or fire. Many fires have been caused by faulty or overloaded wiring, or both. For safe wiring:

1. Use wiring materials approved by and bearing the label of the Underwriters' Laboratories.

2. Install the approved materials in accordance with requirements of (a) the National Electrical Code and (b) local codes.

FUSES AND CIRCUIT BREAKERS: Circuits must be protected against excessive currents by fuses or circuit breakers because excessive currents are fire hazards.

The ordinary fuse contains a small metal strip which melts at a lower temperature than the copper of the circuit wires. When the strip melts, the fuse is said to be "blown." Then it is necessary to ***remove the cause of the excessive current,*** after which the blown fuse can be replaced. Fuses should be Type S, required by the National Electrical Code; they cannot be replaced by a fuse of higher rating and cannot be tampered with readily.

The circuit breaker opens the circuit on excessive currents. When this happens, the breaker is "tripped." ***After the cause of the excessive current is removed,*** the breaker is re-set by moving the handle back to the "on" position.

OTHER CAUTIONS: For safety, do not locate switches and outlets near bathtubs, washtubs, or sinks. Danger of electrocution lies in receiving a shock when a part of your body is in water.

Place switches and outlets away from radiators, metal registers, and metal piping to minimize the possibility of shock.

Use only non-metallic sockets in the basement. All pull chains used there should be of the insulated type.

Keep appliance cords in good condition.

Do not use makeshift extension wiring. Many dangers arise from practices such as stapling a cord to a baseboard.

ECONOMICAL WIRING

To be economical the wiring system must be:

1. Installed to meet present and future needs. It is much cheaper to wire a house adequately when it is being built than to make additions and replacements in the wiring system later.

2. Constructed of high quality materials. High quality wiring and wiring devices are necessary for a lasting job. Inferior materials often require untimely replacements, resulting in additional expense for labor and materials. Guard against the use of inferior materials by selecting a reliable electrical contractor.

3. Installed in a workmanlike manner. Good materials alone cannot assure a good wiring job. They must be installed by a qualified electrician, or extensive repair bills may follow.

ADEQUATE WIRING

• Just as any highway system must be planned to handle present and future traffic, so must the wiring system be planned to answer the needs of today ***and*** tomorrow.

A wiring system will not be satisfactory unless each of the following parts is adequate: (1) service, (2) main distribution cabinet, (3) subfeeders and branch distribution cabinets, if used, (4) branch circuits for present use, (5) spare circuits [for future use] in the distribution cabinets. A large number of convenience outlets does not mean that a wiring system is adequate; for without sufficient branch circuits of proper capacity, the outlets will be of little value. The room-by-room requirements for adequate wiring will be discussed more in detail in a forthcoming circular on *"Wiring in the Home."*

Although the results of too much traffic on a highway are well known, the results of an inadequate, overloaded wiring system are less obvious. They are:

1. Fuses must be replaced frequently or circuit breakers re-set often.
2. Light bulbs burn dim yellow.
3. Lights dim each time the refrigerator motor or any other motor starts, or an appliance requiring considerable current is operating.
4. Heat-producing appliances such as ranges, toasters, irons come up to temperature more slowly and may never reach the desired temperature.
5. One appliance may have to be disconnected before another can be used.
6. Motors run more slowly, cannot deliver the same power, and get hotter than normally.
7. An appreciable part of the cost of electricity may be caused by heating produced in overloaded wiring throughout the house.

CONVENIENT WIRING

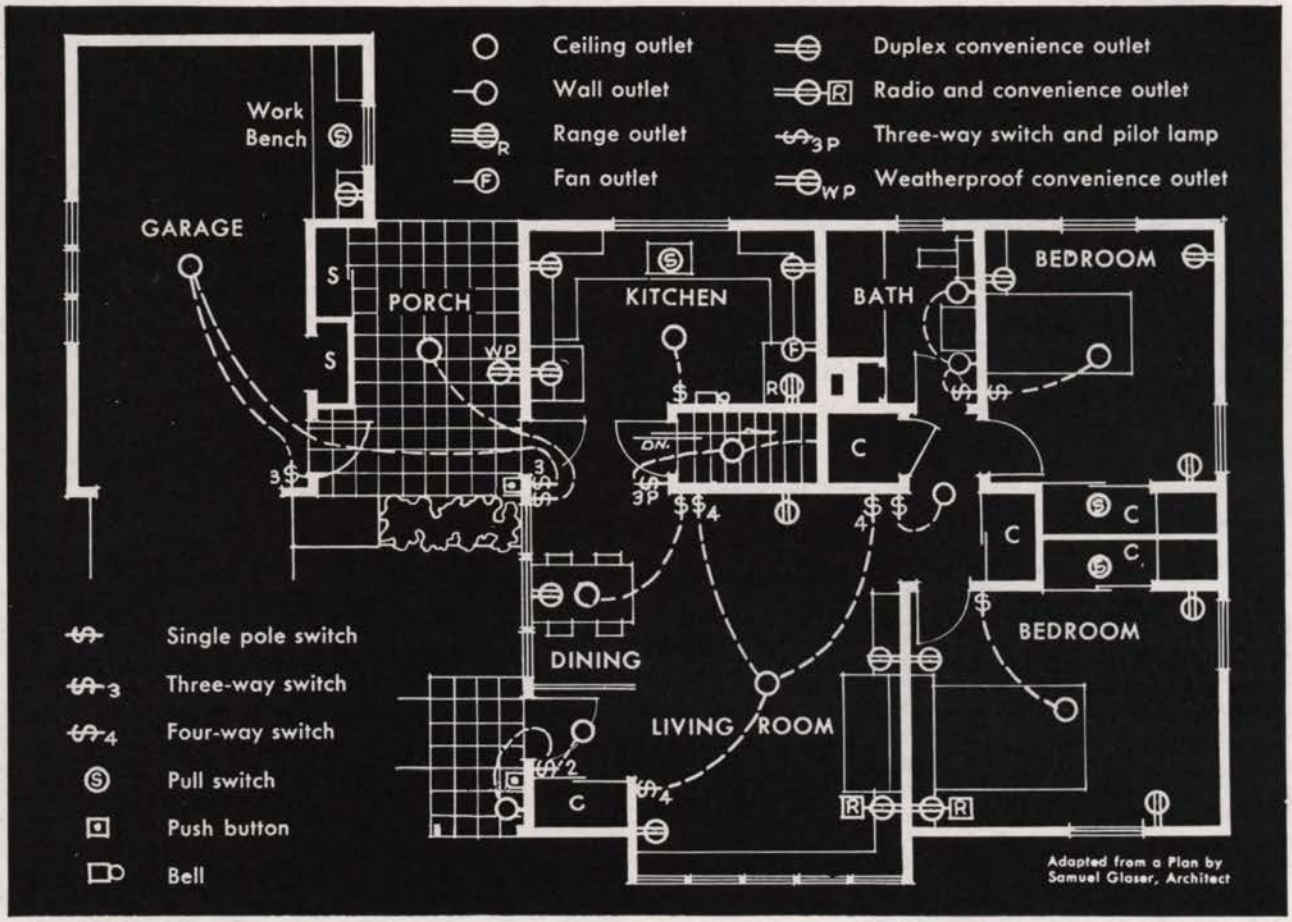
There should be enough outlets in all rooms for auxiliary equipment likely to be used. But the fact that there are many outlets and switches does not necessarily mean that they will be conveniently located.

1. Locate convenience outlets in each room on the basis of their possible use with lamps, radios, clocks, other appliances, and various arrangements of furniture. Generally this will require at least one convenience outlet for each 10-12 feet of wall unbroken by a doorway, and at least one in each broken wall space 3 feet or more in length. Selection of locations of the outlets will require cooperative planning between the home owner, the architect or builder, and the electrical contractor.
2. If the most commonly used entrances to a room are more than ten feet apart, locate a switch at each of the entrances to control the general light. If most of the general light comes from portable lamps, some convenience outlets, too, should be controlled from the doorways.
3. Install switches at the top and bottom of first-to-second floor stairs, top and bottom of basement stairs, and bottom of attic stairs.
4. Put a switch at each end of every long hall.
5. Install switches so the garage lights can be controlled at both the garage and house.
6. Whenever practical, wire half of the outlets in a room on one circuit and the other half on another. Thus, if trouble occurs on one circuit, only half of the outlets will be affected.

COMMUNICATIONS: Although telephone and radio outlets, doorbells, chimes, buzzers, and annunciators are additions to the wiring system which result in convenience, they are so specialized in their functions that they will be treated in a future circular on communications.

KNOW HOW TO READ YOUR PLAN

You should learn to recognize the standard symbols for a ceiling outlet, wall outlet, convenience outlet, wall switch, range outlet, and a few others commonly used. A careful study of the plan below will acquaint you with some of the more important symbols. You should study them to make sure that your requirements for electrical use are fully provided for.



POINTS TO CONSIDER:

Duplex convenience outlets should be carefully located, particularly in the living room or bedroom so furniture can be rearranged. The location of special outlets for everyday appliances must be carefully anticipated.

Weatherproof outlets with protecting caps are necessary for lamps, Christmas trees, etc., on your porch or terrace.

Pull-chain sockets should be used only for areas such as small closets or work benches where supplementary lighting is needed, yet a wall switch is not necessary.

The location of switches must not be behind doors or in inaccessible places. The height of sinks, tables, or built-in cupboards is often the determining factor in the location of switches, outlets, and lights.

Multiple control switches are desirable in many hallways and some rooms so lights can be controlled from more than one switch. The garage light should be controlled from both the garage and the house. In the plan above, the living room ceiling fixture is controlled from near the front entrance, kitchen, and bedroom hall. The basement light should have a switch at the head and at the foot of the basement stairs.

Pilot light switches save electricity. Locate one at the head of the basement stairs to remind you when the basement light is burning. The switch in the house for the garage light should also have a pilot light.

Night lights (which take little electricity) contribute to safety and convenience when one is attending small children or sick persons.

CAUTION: People are often misled by statements that a certain seemingly large *total* number of "outlets" or "openings" will be in their house. The general terms "outlets" and "openings" include receptacles for switches and fixtures, and do not necessarily mean convenience outlets.

Check your plan *room by room* to be sure it has the number of convenience outlets (as well as receptacles for switches and fixtures) that you need or want.